CLAIMS:

1. An apparatus for processing an ambient sound signal including:

input means for receiving the ambient sound signals;

means for performing a Fourier transform on the input signal and providing an input spectrum having discrete frequency components each including a coefficient defining the magnitude of the component;

means for multiplying the magnitude coefficients by a predetermined gain value and providing magnitudeadjusted frequency components;

means for comparing the amplitude of the magnitude adjusted frequency components with predetermined values;

means for attenuating the magnitude of those adjusted frequency components whose magnitude is greater than the predetermined values; and

output means for an output spectrum signal including the frequency components and respective adjusted and attenuated magnitudes.

2. The apparatus according to claim 1, wherein the means for performing a Fourier transform, the means for multiplying the magnitude coefficients, the means for comparing the amplitude, and the means for attenuating the amplitude are implemented by a programmed microprocessor coupled to memory storage means.

3. The apparatus according to claim 2, wherein the predetermined values are based upon hearing response parameters.

4. The apparatus according to claim 3, wherein the hearing response parameters comprise any one or more of loudness discomfort levels, maximum comfortable levels, comfortable levels, optimum audibility levels, and threshold levels for each of the plurality of frequency components.

5. The apparatus according to claim 1, further including means to perform an inverse Fourier transform on the output spectrum signal.

6. The apparatus according to claim 5, further including a digital to analogue converter to convert the output of the inverse Fourier transform to an analogue signal.

7. The apparatus according to claim 6, further including means for applying said analogue signal to an electro-acoustical middle ear transducer.

8. The apparatus according to claim 6, further including means for applying said analogue signal to an electro-mechanical middle ear transducer.

9. The apparatus according to claim 2, further including means for processing said output spectrum signal into an electrical signal to be applied to an electrode array of a cochlear implant.

10. The apparatus according to claim 1, incorporated as the front-end of a further signal processor.

11. The apparatus according to claim 1, wherein the microprocessor is programmed to calculate and store in memory, distribution values indicative of the distribution of the magnitude of each of said plurality of adjusted frequency components over a period of time.

12. The apparatus according to claim 11, wherein the microprocessor is programmed to determine and store in memory, one or more distribution values which are approximately the 30th, 70th, 90th and 98th percentiles of the magnitude of each of said plurality of adjusted frequency components over a period of time.

13. The apparatus according to claim 1, wherein the means for attenuating includes a plurality of limiting means responsive to said magnitude adjusted analysis signals and arranged to limit the power of each of said signals to below a corresponding plurality of predetermined levels.

14. A method for processing an ambient sound signal including the steps of:

performing a Fourier transform on the ambient sound signal and generating an input spectrum having discrete frequency components each including a co-efficient defining the magnitude of the component;

multiplying the magnitude coefficients by a predetermined gain value and providing magnitude adjusted frequency components;

comparing the amplitude of the magnitude adjusted frequency components with predetermined values;

attenuating the magnitude of those adjusted frequency components whose magnitude is greater than the predetermined values; and

providing an output spectrum signal including the frequency components and respective adjusted and attenuated magnitudes.

15. The method according to claim 14, wherein the predetermined values are based upon hearing response parameters.

16. The method according to claim 15, wherein the hearing response parameters comprise any one or more of loudness discomfort levels, maximum comfortable levels, comfortable levels, optimum audibility levels, and threshold levels for each of the plurality of frequency components.

17. The method according to claim 16, further including the step of performing an inverse Fourier transform on the output spectrum signal in the time domain.

18. The method according to claim 17, wherein the output subsequent to the inverse Fourier transform is converted to an analogue signal by means of an analogue to digital converter.

19. The method according to claim 18, further including the step of feeding said analogue signal to an electro-acoustical middle ear transducer.

20. The method according to claim 18, further including the step of feeding said analogue signal to an electro-mechanical middle ear transducer.

21. The method according to claim 14, further including the step of processing said output spectrum signal into an electrical signal to be applied to an electrode array of a cochlear implant.

22. The method according to claim 14, further comprising the step of calculating and storing in memory, distribution values indicative of the distribution of the magnitude of each of said plurality of adjusted frequency components over a period of time.

23. The method according to claim 14, further comprising the step of determining and store in memory, one or more distribution values which are approximately the 30th, 70th, 90th and 98th percentiles of the magnitude of each of said plurality of adjusted frequency components over a period of time.

24. A method for processing an ambient sound signal including the steps of:

a) performing a frequency analysis on the ambient sound signal to generate a plurality of analysis signals corresponding to the ambient sound signal;

b) multiplying each of said plurality of analysis signals by a corresponding one of a plurality of gain values to produce a plurality of magnitude adjusted analysis signals;

c) determining distribution values characteristic of the amplitude distribution of each of the plurality of magnitude adjusted analysis signals over a period of time;

d) setting said gain values on the basis of comparisons between said distribution values and any one or more of a plurality of hearing response parameters;

e) processing said plurality of magnitude adjusted analysis signals to form an output signal;

and

g) feeding said output signal to a monaural or binaural system having any one or more selected from the group comprising: a headphone, a hearing aid, a cochlear implant and a mechanical activator driving an ossicle in the middle ear of a patient.

25. The method according to claim 24, wherein the plurality of hearing response parameters includes any one or more selected from the group comprising comfort targets, audibility targets, maximum comfortable levels, optimum audibility levels and threshold levels.

26. The method according to claim 24, wherein the distribution values comprise statistical values representing the distribution of the magnitude of each of said plurality of magnitude adjusted analysis signals over a period of time.

27. The method according to claim 24, wherein the distribution values include ith percentile values of the distribution of the magnitude of each of said plurality of magnitude adjusted analysis signals over a period of time.

28. The method according to claim 24, wherein the distribution values determined are ith percentile values being approximately one or more of the 10th, 30th, 70th, 90th, and 98th percentiles.

29. The method according to claim 24, wherein step c) the determining of said distribution values includes the step of comparing the magnitude of a magnitude adjusted analysis signal with a distribution value being one of said ith percentile values, said distribution value being reduced by a first step size or increased by a second step size depending on the outcome of said comparison.

30. The method according to claim 24, wherein the ratio of the first step size to the second step size is equal to i/(100-i).

31. The method according to claim 24, further including the step of:
ensuring that each of the plurality of magnitude adjusted analysis signals is less than a corresponding predetermined maximum power output level.

32. The method according to claim 24, wherein said frequency analysis comprises the application of a Fourier transform to said ambient signal.

33. The method according to claim 24, further including the steps of performing an inverse fast Fourier transform upon the plurality of adjusted frequency components to produce a digital time domain signal; and converting said digital time domain signal to an analogue signal.

34. The method of according to claim 24, wherein said processing step includes converting said combined signal into a signal conforming to the respective binaural system.

35. A method for processing an ambient sound signal including the steps of:

a) performing a frequency analysis on the ambient sound signal to generate a plurality of analysis signals corresponding to the ambient sound signal;

b) multiplying each of said plurality of analysis signals by a corresponding one of a plurality of gain values to produce a plurality of magnitude adjusted analysis signals;

c) determining distribution values characteristic of the amplitude distribution of each of the plurality of magnitude adjusted analysis signals over a period of time;

d) setting said gain values on the basis of comparisons between said distribution values and a plurality of hearing response parameters

e) processing said plurality of magnitude adjusted analysis signals to form an electric output signal; and

f) feeding said output signal to a cochlear implant system.

36. A method for processing an ambient sound signal including the steps of:

a) performing a frequency analysis on the ambient sound signal to generate a plurality of analysis signals corresponding to the ambient sound signal;

b) multiplying each of said plurality of analysis signals by a corresponding one of a plurality of gain values to produce a plurality of magnitude adjusted analysis signals;

c) determining distribution values characteristic of the amplitude distribution of each of the plurality of magnitude adjusted analysis signals over a period of time;

d) setting said gain values on the basis of comparisons between said distribution values and a plurality of hearing response parameters

e) combining said plurality of magnitude adjusted analysis signals to form a combined signal;

f) processing said combined signal to generate an output signal; and

g) feeding said output signal to a mechanical activator driving an ossicle in the middle ear of a patient.

37. A method for processing an ambient sound signal for a binaural system, including the steps of:

a) performing a frequency analysis on the ambient sound signal to generate a plurality of analysis signals corresponding to the ambient sound signal;

b) multiplying each of said plurality of analysis signals by a corresponding one of a plurality of gain values to produce a plurality of magnitude adjusted analysis signals;

c) determining distribution values characteristic of the amplitude distribution of each of the plurality of magnitude adjusted analysis signals over a period of time;

d) setting said gain values on the basis of comparisons between said distribution values and a plurality of hearing response parameters

e) combining said plurality of magnitude adjusted analysis signals to form a combined signal;

f) processing said combined signal to generate a sound output signal; and

g) feeding said sound output signal to a hearing aid, or a headphone, or other electro-acoustic output transformer..

38. An apparatus for processing an ambient sound signal including:

a) a frequency analysis means arranged to generate a plurality of analysis signals corresponding to said ambient signal;

b) a magnitude adjustment means coupled to the frequency analysis means and arranged to adjust the magnitude of each of said analysis signals to produce a plurality of magnitude adjusted analysis signals;

c) a distribution estimation means responsive to said plurality of magnitude adjusted analysis signals and arranged to generate distribution values characteristic of the amplitude distribution of each of the said plurality of magnitude adjusted analysis signals over a period of time; and

d) a comparison means coupled to the distribution estimation means and arranged to perform comparisons of said distribution values with predetermined hearing response parameters, said comparison means controlling said magnitude adjustment means on the basis of said comparisons;

wherein the magnitude adjustment means, the distribution estimation means and the comparison means are implemented by a programmed microprocessor coupled to memory storage means, said memory means storing the hearing response parameters and include at least one the maximum comfortable levels, optimum audibility levels and threshold levels for each of the plurality of frequency components.

39. A computer readable medium, having a program recorded thereon, where the program is configured to cause a computer to execute a method for processing an ambient sound signal, said method including the steps of:

a) performing a frequency analysis on the ambient sound signal to generate a plurality of analysis signals corresponding to the ambient sound signal;

b) multiplying each of said plurality of analysis signals by a corresponding one of a plurality of gain values to produce a plurality of magnitude adjusted analysis signals;

c) determining distribution values characteristic of the amplitude distribution of each of the plurality of magnitude adjusted analysis signals over a period of time;

d) setting said gain values on the basis of comparisons between said distribution values and any one or more of a plurality of hearing response parameters; and

e) processing said plurality of magnitude adjusted analysis signals to form an output signal.